

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced GCE

CHEMISTRY

Chains, Rings and Spectroscopy

Friday

24 JANUARY 2003

Afternoon

1 hour 30 minutes

2814

Candidates answer on the question paper.

Additional materials:

Data Sheet for Chemistry

Scientific calculator

Candidate Name

Centre Number

Candidate
Number

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TIME 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in the spaces on the question paper.
- Read each question carefully and make sure you know what you have to do before starting your answer.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- You may use the *Data Sheet for Chemistry*.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	11	
2	13	
3	12	
4	11	
5	13	
6	13	
7	8	
8	9	
TOTAL	90	

This question paper consists of 16 printed pages.

Answer **all** the questions.

- 1 Benzene, methylbenzene and phenol are used in the chemical and pharmaceutical industry as starting materials for making more complex aromatic compounds.

(a) Methylbenzene can also be made in the laboratory from benzene and chloromethane.

(i) Draw the structural formula of methylbenzene.

[1]

(ii) Give the equation for the preparation of methylbenzene from benzene.

[1]

(iii) Identify, by name or formula, a suitable catalyst for this reaction.

.....[1]

(iv) Methylbenzene is more reactive than benzene.

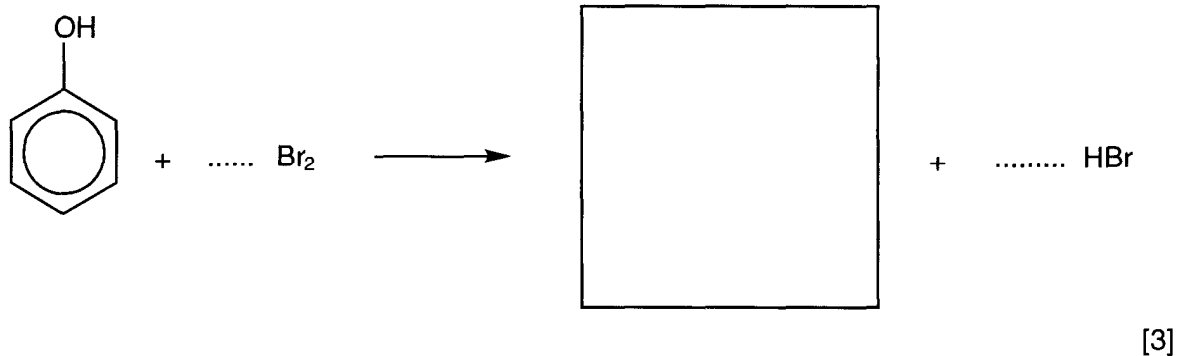
Name and draw the structural formula of an **organic** product which might be formed from the reaction of methylbenzene with chloromethane in the presence of the catalyst.

structural formula

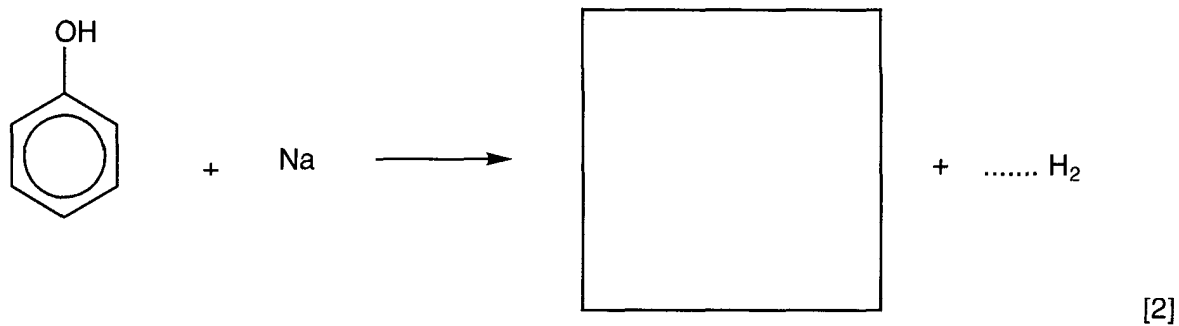
name[2]

(b) Complete and balance the following equations for the reactions of phenol, giving structural formulae for the organic compounds in the boxes provided.

(i)



(ii)



(c) State a general use for phenols.[1]

[Total: 11]

- 2 Glycine is an amino acid obtained from natural proteins by digestion. The structure of glycine is $\text{CH}_2(\text{NH}_2)\text{COOH}$.

(a) State **in words** the three dimensional shape adopted by the **bonds** in a molecule of glycine

(i) around the nitrogen atom,

.....[1]

(ii) around the carbon atom of the CH_2 group,

.....[1]

(iii) around the carbon atom of the COOH group.

.....[1]

(b) Amino acids react both with acids and with bases. Draw the structure you expect for glycine

(i) in acidic solution,

[1]

(ii) in alkaline solution.

[1]

(c) Proteins can also be converted into amino acids in the laboratory.

(i) State the reagents and conditions required.

.....[2]

(ii) State the type of reaction taking place.

.....[1]

- (d) Alanine, $\text{CH}_3\text{CH}(\text{NH}_2)\text{COOH}$, is another amino acid obtained from proteins. Alanine has a chiral centre but glycine does not.

(i) What is meant by the term *chiral centre*?

.....
.....[1]

(ii) Draw the two stereoisomers of alanine.

[2]

(iii) Would you expect the alanine isolated from a protein to be:

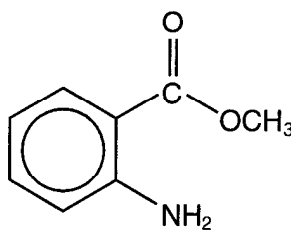
- either** only one stereoisomer
- or** a 1:1 mixture of both stereoisomers
- or** unequal amounts of the two stereoisomers?

Tick one answer and explain your choice.

.....
.....
.....
.....[2]

[Total: 13]

- 3 Many organic compounds are used to add flavour to food and drink. Compound **A** has been used to add grape flavour to soft drinks.

**A**

- (a) Apart from the benzene ring, name the **two** functional groups in **A**.

.....
[2]

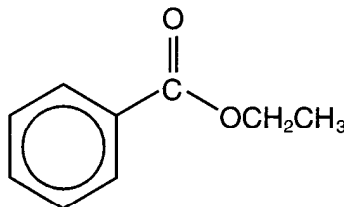
- (b) (i) Deduce the molecular formula of **A**.

.....[1]

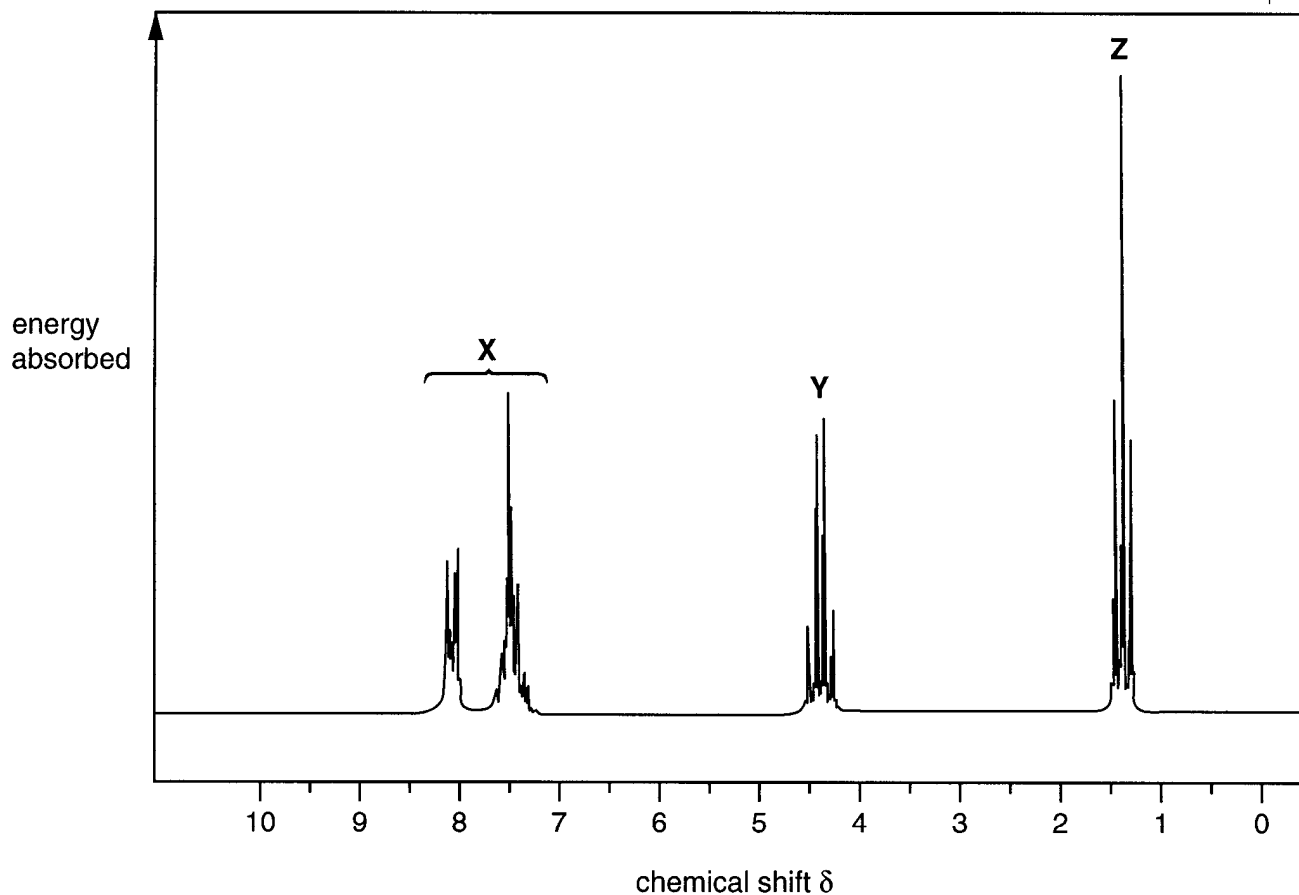
- (ii) A 330 cm³ can of soft drink contains 0.100 g **A**.
 Calculate the concentration, in mol dm⁻³, of **A**.

concentration mol dm⁻³ [2]

- (c) Compound **B** is similar to **A** and also has a fruity odour.

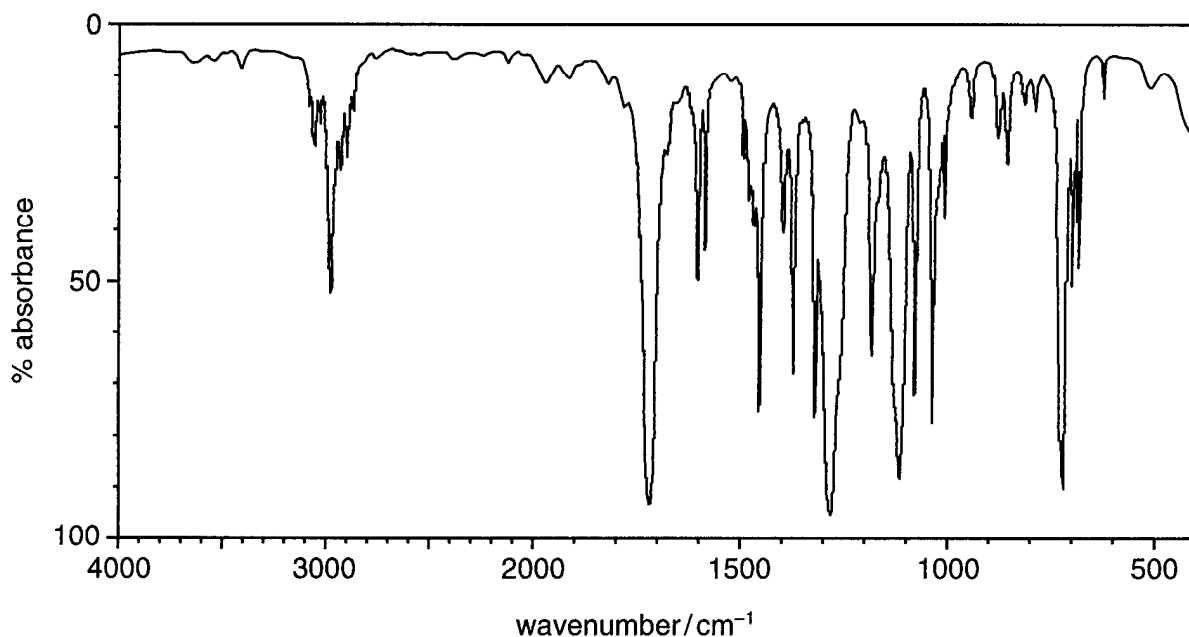
**B**

- From the δ values, identify which of the protons of **B** are responsible for each of the groups of peaks **X**, **Y** and **Z**. Treat the peaks at δ 7–9 as a single group. Show your reasoning in your answer.



[6]

- (ii) The infra-red spectrum of **B** is shown below. Mark with a cross the **major** absorption peak which is characteristic of the $-\text{COOCH}_2\text{CH}_3$ group.



[1]

[Total: 12]

- 4 The nitration of an aromatic compound is the first stage in the synthesis of many commercially important compounds.

- (a) (i) Describe the mechanism of the nitration of benzene. Include the reagents and overall equation in your answer, and show how the electrophile is generated.

[6]

(ii) Explain why this is classified as an *electrophilic substitution* reaction.

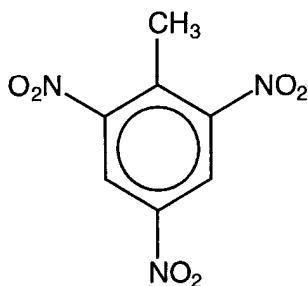
.....

.....

.....

.....[2]

(b) Compound **C** is an aromatic nitro compound.



C

Predict the chemical shifts of the peaks in the n.m.r. spectrum of **C**.

.....

.....

.....

.....[3]

[Total: 11]

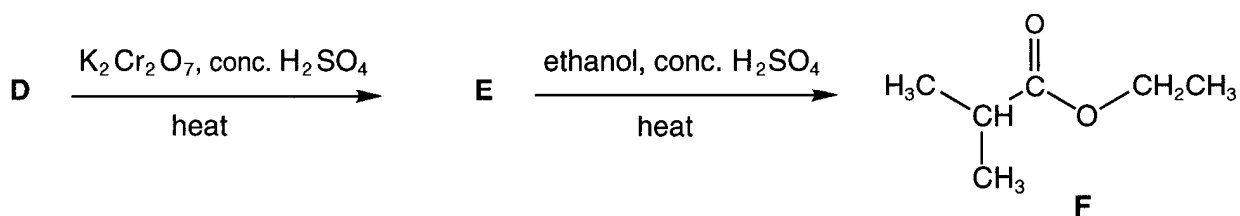
5 Compounds with the formula C_4H_9OH are alcohols.

(a) Draw formulae to show the four structural isomers of alcohols with the molecular formula $C_4H_{10}O$.

[4]

(b) One of the isomers in (a), compound **D**, reacts with $K_2Cr_2O_7$ in the presence of H_2SO_4 , to give **E**.

When **E** is heated with ethanol in the presence of concentrated H_2SO_4 , compound **F** is formed.



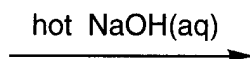
- State the reaction, if any, of **each** of your alcohols in (a) with acidified $\text{K}_2\text{Cr}_2\text{O}_7$. Use this information and the reactions above to identify **D** and **E**. Give your reasoning.

[5]

(ii) Write the equation for the formation of **F** from **E**.

.....[1]

- C1CCC(=O)OC1
- G**

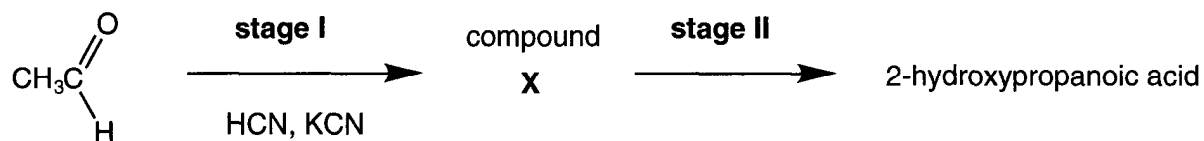


[2]

[Total: 13]

- 6 2-Hydroxypropanoic acid (lactic acid) is present in milk. It can also be made in two stages from ethanal.

The laboratory synthesis of 2-hydroxypropanoic acid is outlined below.



- (a) (i) Give the mechanism for **stage I**.

[4]

- (ii) Describe the second stage of the synthesis by suggesting a suitable reagent and stating the type of reaction involved.

reagent:

type of reaction:

[2]

- (iii) Draw the structure of 2-hydroxypropanoic acid.

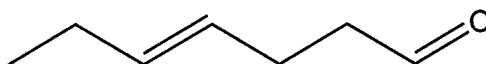
[1]

- (b) 2-Hydroxypropanoic acid was dissolved in D_2O and an n.m.r. spectrum of the solution was taken. Predict, with reasons, the **splitting patterns** observed in this spectrum.

.....

[2]

- (c) Hept-4-enal, **H**, is also present in milk.

**H**

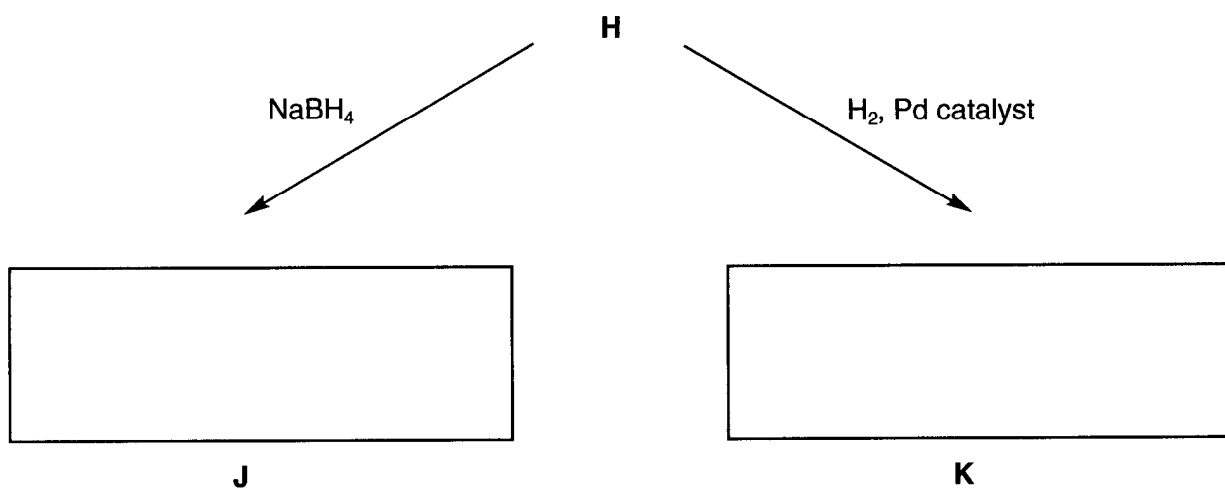
- (i) Deduce the molecular formula of **H**.

.....[1]

- (ii) Draw the skeletal formula of a stereoisomer of **H**.

[1]

- (iii) **J** and **K** can be made from **H**.
 Draw skeletal formulae for **J** and **K** in the boxes provided.

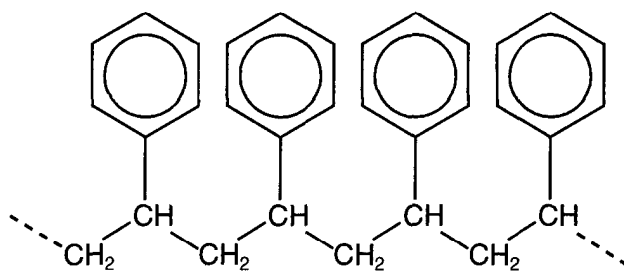


[2]

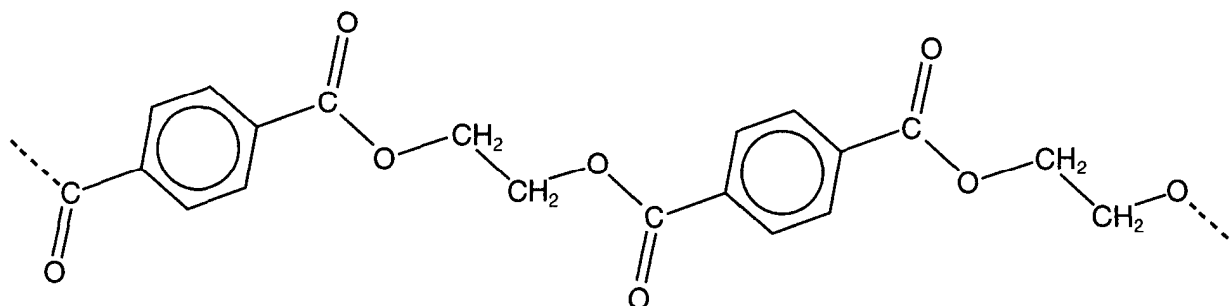
[Total: 13]

- 7 Polymers can be made either from a single monomer or from more than one monomer. Two polymers, **L** and **M**, are shown below.

Polymer
L



Polymer
M



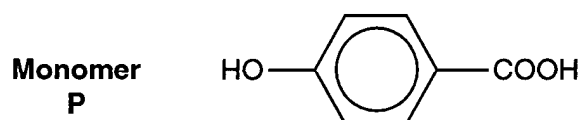
- (a) Deduce the structures of the monomers from which **L** and **M** could be obtained.

For **L**:

For **M**:

[3]

- (b) Polymer **N** can be made from the monomer **P** only, shown below.



Suggest a structure for polymer **N**, showing three repeat units.

[2]

- (c) Polymers **M** and **N** are made by the same type of polymerisation.
Name this type of polymerisation and describe its characteristic features.

.....
.....
.....
.....[2]

- (d) State a major use for polymers such as **M**.

.....[1]

[Total: 8]

Ketones of different chain lengths are important to the flavour of dairy foods. You are given a sample of an unknown ketone isolated from cheese.

- detect the presence of a carbonyl group in your compound,
- confirm that it is a ketone and not an aldehyde,
- use a chemical method to identify which ketone you have.

[8]

[Total: 9]